What is the molar mass of a gas that diffuses one fifth as fast as helium? **(E12)**

ses

itions for deviating from the ideal gas law

ors that the ideal gas law neglects

choice:

ed, rigid flask contains nitrogen gas. The flask is cooled from room temperature)°C. Which of the following statements is true?

e number of moles of nitrogen decreases.
e volume of nitrogen increases.
e pressure of nitrogen decreases.
e pressure of nitrogen increases.
e volume of nitrogen decreases.

deal gas law predicts that

- the volume of a gas goes to zero at absolute zero temperature.
- density increases with pressure.
- density increases with temperature.
- the product, PV/T, for a fixed amount of gas is constant.

number of true statements above is

b. 1 **c.** 2 **d.** 3 **e.** 4

3. The gas constant, R, can have the units

— bar-m^3/mol-K
— bar-L/mol-K
— mm Hg-cm^3/mol-K
— mol-K/mm Hg-mL

The number of false statements above is
a. 0 **b.** 1 **c.** 2 **d.** 3 **e.** 4

4. In an ideal gas, the collisions of the molecules with the walls of the container account for
a. the velocity of the molecules.
b. the observed pressure.
c. the number of moles.
d. the observed temperature.
e. none of these.

5. For a fixed amount of gas at a fixed pressure, changing the temperature from 30°C to 60°C causes
a. the gas volume to decrease.
b. the gas volume to double.
c. the gas volume to increase but not to double.
d. the gas volume to decrease to half its original volume.
e. no change in the gas volume.

6. Attractive forces between gas molecules are most important at
a. low pressures and low temperatures.
b. low pressures and high temperatures.
c. high pressures and high temperatures.
d. high pressures and low temperatures.

B. Answer the questions below, using **LT** (for *is less than*), **GT** (for *is greater than*), **EQ** (for *is equal to*), or **MI** (for *more information required*) in the blanks provided.

_____ **1.** At 100°C and 1 atm, the velocity of a molecule of hydrogen gas is (1) the velocity of a molecule of oxygen gas.

_____ **2.** At 100°C, the average translational kinetic energy of a molecule of hydrogen gas is (2) the average translational kinetic energy of a molecule of oxygen gas.

_____ **3.** At constant temperature and volume, the pressure exerted by ten moles of hydrogen gas is (3) the pressure exerted by ten moles of oxygen gas.

_____ **4.** At the same temperature and volume, the pressure exerted by 10.00 g of hydrogen gas is (4) the pressure exerted by 10.00 g of oxygen gas.

_____ **5.** At 50°C, the velocity of a molecule of chlorine gas is (5) the velocity of the same molecule of chlorine gas at 100°C.

_____ **6.** At a constant volume, the pressure of 2.00 g of SO_2 (g) ($\mathcal{M}$ = 64.0 g/mol) at 400 K is (6) the pressure of 2.00 g of O_2 (g) ($\mathcal{M}$ = 32.0 g/mol) at 200 K.

C. True or False:

Consider 2 flasks with the same volume, temperature and pressure. One flask contains nitrogen gas, the other flask has helium gas.

_____ **1.** Both flasks have the same number of moles.

_____ **2.** The nitrogen gas in one flask has a lower density than the helium gas in the other flask.

_____ **3.** If a pinhole is created in both flasks, nitrogen gas would effuse faster than the hydrogen gas.

_____ **4.** The average translational energy of the gases in both flasks is the same.

_____ **5.** One mole of CO_2 gas is introduced to each flask. In the resulting mixture of gases, the mole fraction of nitrogen is equal to the mole fraction of helium.

D. Problems:

Consider ammonia gas (NH_3), which is produced by reacting nitrogen gas and hydrogen gas.

1. Write a balanced equation for the reaction.

2. A flask at a certain temperature contains 0.20 mol of nitrogen at a pressure of 1.5 atm. An identical flask at the same temperature contains 0.60 mol of hydrogen gas. What is the pressure of the hydrogen gas?

3. The same gases in Problem 2 are combined and put into a 3.0-L flask. The g mixture exerts a total pressure of 6.0 atm. What temperature does the gas mixt have?

4. The ammonia produced by reacting 0.200 mol of nitrogen and 0.600 mol of hydrog is measured to be 5.00 L at 27°C and one atm. How many moles of nitrogen we used up in the reaction?

5. Using the data in Problem 4, calculate the partial pressure of each gas in the rea tion vessel if all the gases remain in the vesselafter the reaction takes place. Tl temperature of the vessel is 27°C and the pressure in the vessel is 3.0 atm.

6. Calculate the density of ammonia at 27°C and 1.0 atm pressure.

7. How much faster does the hydrogen diffuse than the nitrogen?

8. Calculate the average speed of an ammonia molecule at 77°C in miles/hour (mph), if oxygen has an average speed of 482 m/s at 25°C.

ANSWERS

Exercises:

(E1) 3.62 bar

(E2) 1.090 bar

(E3) 6.22 K

(E4) 36.6 g/mol

(E5) 16.0 g/mol

(E6) $2\,Na\,(s) + 2\,H_2O\,(\ell) \rightarrow 2\,Na^+\,(aq) + 2\,OH^-\,(aq) + H_2\,(g)$; 1.14 L

(E7) 5.80 L; 18.0 g

(E8) 708 mm Hg; 0.151 g; 1.34 g

(E9) 0.00801 mol; 0.0272 mol; $P_{nitrogen}$ = 200 mm; P_{oxygen} = 480 mm

(E10) 4.50×10^2 K

(E11) 3.03×10^4 m/s; 1.83×10^5 K

(E12) 1.00×10^2 g/mol

Self-Test

A. Multiple Choice:

1. c **2.** d **3.** b **4.** b **5.** c **6.** b

B. Less than, Equal to, Greater than

1. GT **2.** EQ **3.** EQ **4.** GT **5.** LT **6.** EQ

C. True or False

1. T **2.** F **3.** F **4.** T **5.** T

D. Problems:

1. $N_2\,(g) + 3\,H_2\,(g) \rightarrow 2\,NH_3\,(g)$

2. 4.5 atm

3. 2.7×10^2 K

4. 0.101 mol

5. $N_2 = 0.50$ atm; $H_2 = 1.5$ atm; $NH_3 = 1.0$ atm

6. 0.69 g/L

7. 3.72

8. 1.60×10^3 mph